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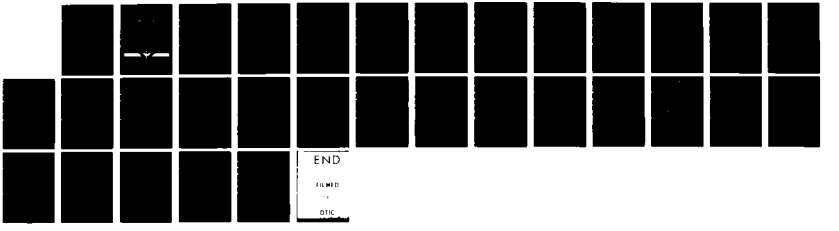

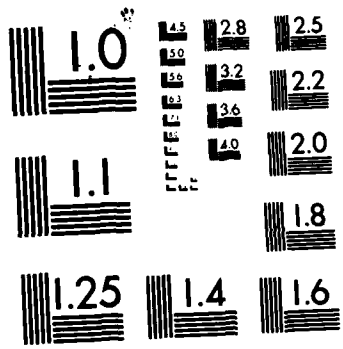

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REPORT NO. T 5/82

SURVEY AND ANALYSIS OF THE HEAT CASUALTY PREVENTION EXPERIMENT FOR RESPHIBLEX 1-81, OPERATION "LANCER EAGLE", 43D, MAU

US ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE

Natick, Massachusetts

JULY 1982

UNITED STATES ARMY MEDICAL RESEARCH & DEVELOPMENT COMMAND

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This report describes the results of a heat casualty prevention experiment conducted in cooperation with reserve elements of the 43D Marine Amphibious Unit, during a training exercise, "Operation Lancer Eagle", which took place at Little Creek, VA and Camp Lejeune, NC in July, 1981. The purpose of the experiment was to evaluate, under field conditions, the effectiveness of a revised approach to the prevention of heat casualties. Four companies of Marines were selected to participate. Two companies (220 men) served as 'controls' and received whatever hot weather training had been provided through

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HUMAN RESEARCH

Human subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRDC Regulation 70-25 on Use of Volunteers in Research.

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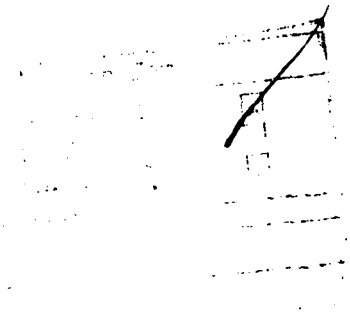

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TECHNICAL REPORT

NO. T5/82

SURVEY AND ANALYSIS OF THE HEAT CASUALTY PREVENTION EXPERIMENT FOR RESPHIBLEX 1-81, OPERATION "LANCER EAGLE", 43D, MAU

by

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Foreword

This report presents the results of a field study conducted in response to a letter from Commanding General 4th Marine Division (REIN), FMF, USMCR, 27 February 1981 to Commanding Officer USARIEM requesting Heat Research Division support during field exercises conducted at Camp Lejeune, North Carolina from 11 to 25 July, 1981. The work was conducted during 43rd Marine Amphibious Unit exercise "Lancer Eagle" at Little Creek, VA and Camp Lejeune, NC. The primary goal of the study was to evaluate the effectiveness of the "Provisional Heat Doctrine" in preventing or reducing the incidence of heat related injuries under simulated combat conditions in a hot/wet environment. The results of this study together with the ancillary findings on current hot weather training procedures and facilities will, it is hoped, provide useful insight into the proper direction of efforts designed to significantly reduce heat injury in military environments.

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Abstract

This report describes the results of a heat casualty prevention experiment conducted in cooperation with reserve elements of the 43D Marine Amphibious Unit, during a training exercise, "Operation Lancer Eagle", which took place at Little Creek, VA and Camp Lejeune, NC in July, 1981. The purpose of the experiment was to evaluate, under field conditions, the effectiver of a revised approach to the prevention of heat casualties.

Four companies of Marines were selected to participate. Two c ies (220 men) served as 'controls' and received whatever hot weather training had been provided through routine channels. The two 'test' companies (306 men) received a thorough briefing on the elements of the Provisional Heat Doctrine and were instructed in the proper use of the Botsball to obtain accurate measurements of local heat stress levels. The 'test' companies were also given a reference card which provided a specific schedule for water intake and work/rest cycles depending on the measured heat stress.

All four companies performed the same training exercises. By the end of the training period, the 'test' companies had sustained an overall heat casualty rate of 4.2% as opposed to 9.1% in the 'control' companies. Thus, the implementation of the Provisional Heat Doctrine appears to have reduced the incidence of heat illness to less than one half of that suffered by the 'control' companies.

Supplementary findings included substantial evidence that the WBGT Index measuring and reporting systems then operating at these training centers, were providing inaccurate and potentially dangerous information on prevailing weather conditions.

Key Words: Botsball, WBGT, water intake, heat illness, work/rest cycles

Introduction

The technological advancements of modern warfare are limited by the ability of man to function normally within a range of hostile environments. Heatstroke has always accompanied man's movement in both hot/dry and hot/wet environments throughout the ages with references found in Biblical, Roman, and Crusader times up to the present. Hot environments are particularly hostile to individuals arriving from temperate climates. Heat casualties in hot environments result from: 1) lack of acclimatization of exposed personnel, 2) absence or limited supply of water, 3) individuals not adhering to a reasonable schedule of increased water intake and modified rest/work cycles, dictated by the prevailing environmental conditions. In no prior conflict (WWII to Vietnam) has the true impact of environmental heat on operational effectivness been adequately measured or documented. For example, according to COL T. F. Whayne (1), Chief, Preventive Medicine Division, OSG, 1951, the data on heat injury coming out of World War II was defective for the following reasons: 1) We have data only on cases severe enough to be admitted to a medical installation. The incidence figures are too low for the milder heat disorders which are not recorded at sick call but affect performance of duty. 2) Criteria for diagnosing heat injury were not generally well understood. 3) Heat casualty rates have a seasonal incidence which are biased by the calculation of annual rates. 4) Study of heat injury on a theater rather than unit basis gives a false picture of the potential military problem.

In 1947, Elizabeth Schichele (2) analyzed 157 of these fatal heatstroke cases and characterized the individual at risk as an obese unseasoned recruit from the northern United States undergoing basic training in the south. Heat illness among recruits, especially Marines, continued to be a problem from the

years since World War II to the mid 1950's when new summer training regulations were introduced (3). In 1954, the Navy Bureau of Medicine and Surgery evaluated a new index of climatic heat stress, called the wet bulb- globe temperature index (WBGT). Sweating was used as a measure of environmental heat stress. In 1956, the WBGT index was adopted by the Training Command at Parris Island to replace the temperature humidity index previously employed. According to Minard (4) in 1967, "in the two year period (1952-1953) before preventive measures were introduced, the average weekly incidence rate of heat casualties at MCRD, Parris Island, during summer months was 39.5 per 10,000. By comparison the corresponding rate at MCRD was 12.5 in 1955 with a further significant drop to 4.67 in 1956, thus coinciding with the introduction of the present program. The improvement in 1956 occurred despite higher seasonal heat and at less cost in training hours than in 1955." Thus, these data clearly indicate that a heat casualty program geared to the WBGT index can be very successful for recruits (mean weekly incidence rate of 4.7 per 10,000).

Recalling these weekly casualty rates among recruits in the continental U.S., it is interesting to note the casualty rate in the desert area of the Persian Gulf Command in the Middle Eastern Theater during WWII (3). In July 1943, the incidence rate reached 57 per 1000 per year. This figure suggests a mean weekly incidence rate of 11 per 10,000 which agrees well with the 12.5 rate at MCRD in 1955. On the other hand, we must agree with Whayne's original warning, a rate of 57 heat cases per 1000 man-years of desert warfare, appears very low.

Among non-recruits in the Marine Corps during 1961, the incidence rate at non-continental shore stations (1,004 per 100, 000 per year) was 2.5 times higher than at continental stations (405 per 100,000 per year) (4). A major factor in explaining the difference was attributed to the occurrence of heat casualties in Marine Corps units participating in combat exercises conducted in tropical and

subtropical areas. Minard states, "Procedures successful in preventing undue heat stress in recruit training, chiefly by reducing metabolic heat load to offset a rise in environmental heat, cannot be applied to combat, since the level of physical exertion is dictated by the tactical situation. Also, logistical problems in desert climates may lead to shortage of water and hence water rationing." This statement suggests that Minard understood that the Marine Corps had problems with work/rest cycles (metabolic heat load) and water intake (water rationing) in combat scenarios that were not being managed as effectively as during recruit training. Minard, like Whayne 15 years earlier, commented upon the general underestimation of heat casualty rates. For example, Minard states: "Until 1958, medical reporting of heat illness to the Bureau of Medicine and Surgery was limited to cases which were admitted to the sick list. Since 1958 provision has been made on the monthly morbidity report (NAVMED 139) for reporting not only admissions but also cases of heat illness treated on an outpatient basis. These reports fully confirm the finding in field studies that for each case admitted to the sick list there are more than ten unreported cases of milder nature treated as outpatients. Medical statistics based only on hospital admissions, therefore, fail to depict the full impact of heat as a factor of morbidity in military populations." It is unfortunate that 30 years after Whayne indicated that heat casualty statistics from WWII were defective, we have still not initiated service wide procedures to collect this data at the lowest possible level in the military treatment chain (the field medic and aid stations).

According to Terrill (5), "the incidence of heat injury in Vietnam varied from a low of 0.7/1000/day in January to a high of 5.4/1000/day in May. These statistics include only those who required treatment by a medical officer for heat injury and include all logistical and support troops, most of which are never exposed to significant degrees of heat and humidity under stress. A much larger

number of acute heat casualties occur in combat units and are never documented since they are treated by company aidmen or their buddies." Again, there is the now familiar caveat concerning the heat casualty rate, but in spite of this, the Vietnam statistics are impressive. In contrast to the widely-held popular belief that "The Army had no heat problems in Nam", the May casualty rate calculates to a weekly casualty rate of 378 per 10,000. This rate is nearly 35 times higher than that reported for the Persian Gulf in July 1943. If, as has been suggested by many sources (1,4,5), this rate underestimates the number of non-effective soldiers by a factor of 10, we have a military heat illness problem of some significance.

In this report, a heat induced illness is defined as a Marine with heat symptoms and who fails to function for at least 60 min. (i.e. a non-vertical Marine).

This report describes the results of Heat Research Division efforts to field test and evaluate under hot/wet conditions the Provisional Heat Doctrine as a means of reducing military heat casualties. This doctrine is intended to provide a comprehensive approach to the prevention of heat injury which is both conceptually sound and feasible in the field, under heat stress conditions found both in desert and jungle environments. Implementation is assigned as a command responsibility and is based on three fundamental elements: 1) A suitable index relating environmental stress to physiological strain, 2) A small, light, rugged and inexpensive device for measuring the heat index under local conditions (this device automatically compensates for differences found in either jungle or desert environments),and 3) Guidelines for relating fluid intake and work/rest cycles to the index.

Rigorous testing of the Provisional Heat Doctrine in settings as close as possible to actual combat is crucial to an objective and responsible judgement of its effectivness.

Experimental heat stress data collected during the Marine Corps Reserve training exercise CAX 8-80 at 29 Palms, CA (6) substantiated that water intake and work/rest cycles based upon local environmental conditions, the Provisional Heat Doctrine, will prevent loss of human resources. The conclusion drawn from this study is that: "Company Commanders who modify the activity level of their unit as the heat stress level increases and additionally enforce a new water discipline can maintain viable and effective fighting forces under any environmental conditions encountered in the desert".

Although a reduction of heat casualties had been obtained in desert climates, additional data on the adequacy of the new water doctrine for operations in hot humid environments was needed. A heat Casualty Prevention Experiment was conducted during the 43D Marine Amphibious Unit Exercise "LANCER EAGLE", at Little Creek, VA. and Camp Lejeune, NC during July 1981. The main objectives were similar to those of the CAX 8-80 experiment: 1) to maintain and/or improve performance and 2) to reduce the incidence of heat illness (Non-vertical Marines) within test units versus control units.

The 43D MAU consisted of various units with a strength of approximately 1400 men. During the exercise there were 1150 men drawing rations, and this total represents the current best estimate of the force at risk. Approximately 700 men of the 3rd Battalion, 5th Regiment, 4th Marine Division were training at Little Creek, VA from 10-18 July. These units were transported and remained aboard ship (18-20 July) prior to the Amphibious Assault. The remainder of the units of the 43D MAU trained the entire period at Camp Lejeune, NC.

The experimental design to accomplish the proposed Heat Casualty Prevention objectives was kept simple. Two rifle companies ("L" Company, Pittsburgh, PA, and "K" Company, Akron, OH plus "K" Company Detachment, Wheeling, VA) would serve as the test group. This group was given:

(a) A short illustrated field lecture on the subject, "Water As a Tactical Weapon in Preventing Heat Casualties".

(b) A corpsman from each test Company was selected to receive additional instruction on the use of the Botsball and criterion to determine when to inform his Company Commander that the prevailing heat conditions required a change in water consumption and work/rest cycles.

(c) In addition, each corpsman from the test Companies was given copies of a Medical Questionnaire (Incl 4) for collecting heat casualty data. These cards were collected daily by members of the Heat Research Team.

(d) The Commanders of the test Companies were given provisional heat doctrine cards, and additional instructions concerning the experiment and the importance for providing a new water doctrine for all U.S. Ground Forces.

The Control Companies ("M" Company, Columbus, OH, and "I" Company, Buffalo, NY) received no special instructions regarding the prevention of heat illness, other than what had occurred as a result of the normal pre-active duty training which stressed an awareness of the benefit of overdrinking. Each of the corpsmen in these units was given a supply of the Medical Questionnaire cards for collecting heat casualty information. These cards were collected daily by members of the Heat Research Team.

At Little Creek the men were housed in a single multi-storied non-airconditioned barracks. Large fans were positioned in hallways to provide air circulation. Cooled drinking water and cold drink machines were available in the barracks. Food was prepared in an adjacent galley. Breakfast was consumed in the galley, other meals were transported and served at two field mess sites. Water in the field was via water buffalo staged adjacent to the training areas. These water buffaloes were moved as the training schedule dictated, to provide a water source for the training site in use. Each field mess site had one buffalo.

Where possible the water buffaloes were placed in the shade at a convenient location. Due to the sandy beach, it was difficult to place water at the beginning of the breaching beach obstacles course. This bull was placed at the end of the course. Men were transported to training sites in the morning and back to the barracks at the end of the training cycle. Troop movement between training areas required walking.

The training schedule at Little Creek was arranged to provide exposure and practice for each individual Marine during the training period. The training varied from lectures in the air conditioned base theater to a squad assault on a fortified emplacement during the heat of the day, followed by a night amphibious raid. Periods of rest were bracketed with periods of maximum exertion. Movement through the training scenario was determined by WBGT readings taken by the Training Command and promulgated via radio to the course instructors and the liasion officers. Guidelines for activity levels at established WBGT readings were published in the Operations Manual and posted by the Training Command at the Reserve Support Unit. For training purposes, the rifle companies were divided into training companies. Each training company moved through the training cycle as a group staggered from other training companies. No group experienced exactly the same heat risk on the same training site. The scheduled training activities were modified in order to conform to the WBGT reading by rescheduling strenuous activity during periods of less heat risk.

Unlike the garrison training environment at Little Creek, the environment and activity during the Amphibious Assault at Camp Lejeune was dictated by the movement of the training battle. From the landing on the beach until the conclusion of the exercise (21-23 July) men were under field conditions. Rest and sleep were possible only as military objectives were accomplished. Water, when available, was resupplied from five gallon cans. Food consisted of Meals,

Combat, Individual, (MCI's). The normal inconveniences of field conditions were increased by irritating insects and plants and the difficulties of walking over the terrain.

Results

During the period of our participation (11-24 July), we collected heat casualty reporting cards on 71 heat cases. There were 20 heat casualties from the "control" companies (I&M) which represents 91 cases per 1000 men (20 per 220 total). Since all casualties for the entire exercise were grouped within six particular training days (12, 13, 14, 15, 21, and 22 July), this represents a rate of 15 cases per 1000 men per day. In contrast, there were 13 heat casualties from the "test" companies which represents 42 cases per 1000 men (13 per 306 total). This represents a rate of 7 cases per 1000 men per day. There were, thus, over twice as many heat cases per unit of men at risk in "control" than "test" groups. These results provide additional support that the Provisional Heat Doctrine can provide a significant reduction in the incidence of preventable heat illnesses.

Since the peak casualty rate (day 6) for heat exhaustion, headache and cramps averaged 6 cases per 1000 men per day in the desert (CAX 8-80), there appears to be a considerable impact of high humidity on the casualty rate. On the other hand, approximately 50% of the heat cases within both control and test groups occurred during the training at Little Creek. Since these cases occurred during rather short periods of intense activity (1-2 h), there is reason to be concerned about the adequacy of either prehydration or rest during these periods.

In addition, there were 38 heat cases among units not under our direct observation. These cases could not legitimately be included in the final statistical analysis of experimental results. However, a gross combined estimate

(71 casualties per 1150 men per 6 days) indicates a rate of 10.3 casualties per 1000 men per day which is quite high compared to a desert environment (MCB 29 Palms, CA). This would indicate a potential source of concern for hot, humid coastal areas of S.W.A. during the early phases of an amphibious assault without actual combat (some host nation support).

Training activity levels at both Little Creek and Camp Lejeune were subject to modification depending upon the WBGT index. WBGT measurements were made and reported at hourly intervals from 0800 to 1600 hours. Activity was modified according to a schedule of WBGT readings which classified the heat stress into different categories which, in turn, defined safe limits of physical activity. Although the necessary operational procedures and technical facilities to collect and disseminate WBGT data were essentially in place at Little Creek and Camp Lejeune, we discovered factors which, taken together, critically impair the effectiveness of the system.

The first involves consistency in defining codes which categorize the severity of the heat stress. At Little Creek there were three categories of heat stress based on the WBGT index: condition I, II, or III--condition I being the most severe (WBGT 88^{o}F). However, in the operation plan for this exercise, there were four categories, again based on the WBGT: Condition I, II, III, and IV--condition I being the least severe (WBGT = 80^{o}F). The operation plan lists the currently accepted conditon codes. Nevertheless, a statement received in the field that "... we are in heat condition I" could legitimately be interpreted to mean either a) we are in the least dangerous heat condition or b) we are in the most dangerous heat condition. It is difficult to overstate the risks inherent in this situation. If codes of any kind are to be employed, it is crucial that they be consistently defined.

The second involves the quality of the WBGT measurement itself. The specifications for the set up of the WBGT instruments are clearly described in NAVMED P-5052-5. It soon became apparent to us at both Little Creek and Camp Lejeune that the official WBGT readings were significantly higher than the Botsball readings made by us or the test companies. The magnitude of this difference could not be explained by either the known 2^{o} F difference between Botsball and WBGT readings or any reasonable site variations. A total of six WBGT stations were inspected by us: one at Little Creek on 13 July and five at Camp Lejeune on 20 July. At each station we checked the WBGT apparatus, read it as it was, and, at the same time, took a Botsball reading. Complete results are shown in Table 1. All six of the WBGT stations were found to have technically incorrect set-ups, though some were more serious than others in terms of their effect on the readings. The most common problem was inappropriate set-up of the wet-bulb thermometer component of the WBGT which resulted in spuriously high WBGT readings -- in one case more than 13^{o}higher than true. As a result of these technical inadequacies, the reported WBGT conditions appeared much more severe than they really were. This situation poses a serious threat to the credibility of the WBGT system and is especially insidious in that a soldier/commander may gradually come under the illusion that he can operate under 'Black Flag' conditions with no risk and little discomfort. The weather stations at Little Creek and Camp Lejeune had been "Crying Wolf" when there was none. It is crucial that the WBGT stations be maintained according to specifications.

Table 1. WBGT Equipment Deficiencies

DATE	TIME	WEATHER STATION	DEFICIENCY	WBGT READING	BOTSBALL READING
13 July 81	1100	Central-Little Creek VA	1. Mercury bulb & wick of wet bulb thermometer inserted below lip of water reservoir flask.	92.8	84
	1115		- Correct by raising bulb to proper height.	86.4	85
20 July 81	1410	Central**- Camp Lejeune, NC	1. Mercury bulb of wet bulb thermometer immersed in water in reservoir flask.	98.7	84
			2. No wick		
20 July 81	1441	Courthouse Bay- Camp Lejeune, N.C.	1. Mercury bulb & wick of wet bulb thermometer inserted below lip of water reservoir flask.	94.3	86
20 July 81	1530	Rifle Range- Camp Lejeune, N.C.	1. Mercury bulb & wick of wet bulb only 1/4 inch above lip of water reservoir flask.	87.2	86
			2. Water in reservoir very dirty		
			3. Dry bulb inadequate		
20 July 81	1630	Air Station- Camp Geiger, N.C.	1. Wet bulb thermometer taped to stick restricting air flow around wick.	87.5	85
20 July 81	1500	Camp Johnson, N.C.	1. WBGT set-up too low: 2 ft. above ground rather than 4 ft.	83.7	82

*Botsball Reading should be approximately 1.7^{o}F less than reading from a correct WBGT set up.

**The combined average value of all five weather station WBGT readings was used to define the heat index on an hourly basis.

Weather was generally bright to hazy sunshine for all training days at both Little Creek and Camp Lejeune. Botsball readings were taken by us and the two test companies (at Little Creek) at hourly intervals, from 0800 to 1600 hours each training day. Official WBGT data for the training period were obtained from the central station at Little Creek and the five stations at Camp Lejeune.

Figure 1 shows the hourly Botsball and official WBGT data for 12 thru 15 July at Little Creek and 20 thru 22 July at Camp Lejeune. The Botsball readings from the two test companies were averaged together as were the readings from the five WBGT stations at Camp Lejeune.

The WBGT station at Little Creek was corrected, at our request, at 1100 hours on 13 July. As shown in Figure 1, subsequent data from that station showed good correlation with the Botsball readings made by the test companies and by us.

Figure 1 also indicates the number of heat casualties, test and control companies combined, which occurred on each training day. There were no casualties on 20 July because the control and test companies were still aboard ship.

With regard to Figure 1 several other factors should be noted:

1. Weather Conditions at Camp Lejeune presented a more serious heat challenge to the troops. "Red" Botsball conditions persisted for a substantial portion of the day at camp Lejeune, whereas, at Little Creek, daily temperatures showed a rise from fairly cool morning temperatures to a pronounced peak at noon to early afternoon followed by a rapid decline.

2. The 15th of July at Little Creek was by all accounts the coolest of the training days -- (neither the official WBGT nor any of the Botsball readings ever got above $80^{\circ}F$ on that day). Nevertheless, four heat casualties were sustained. This strongly suggests an exertion/dehydration component in these

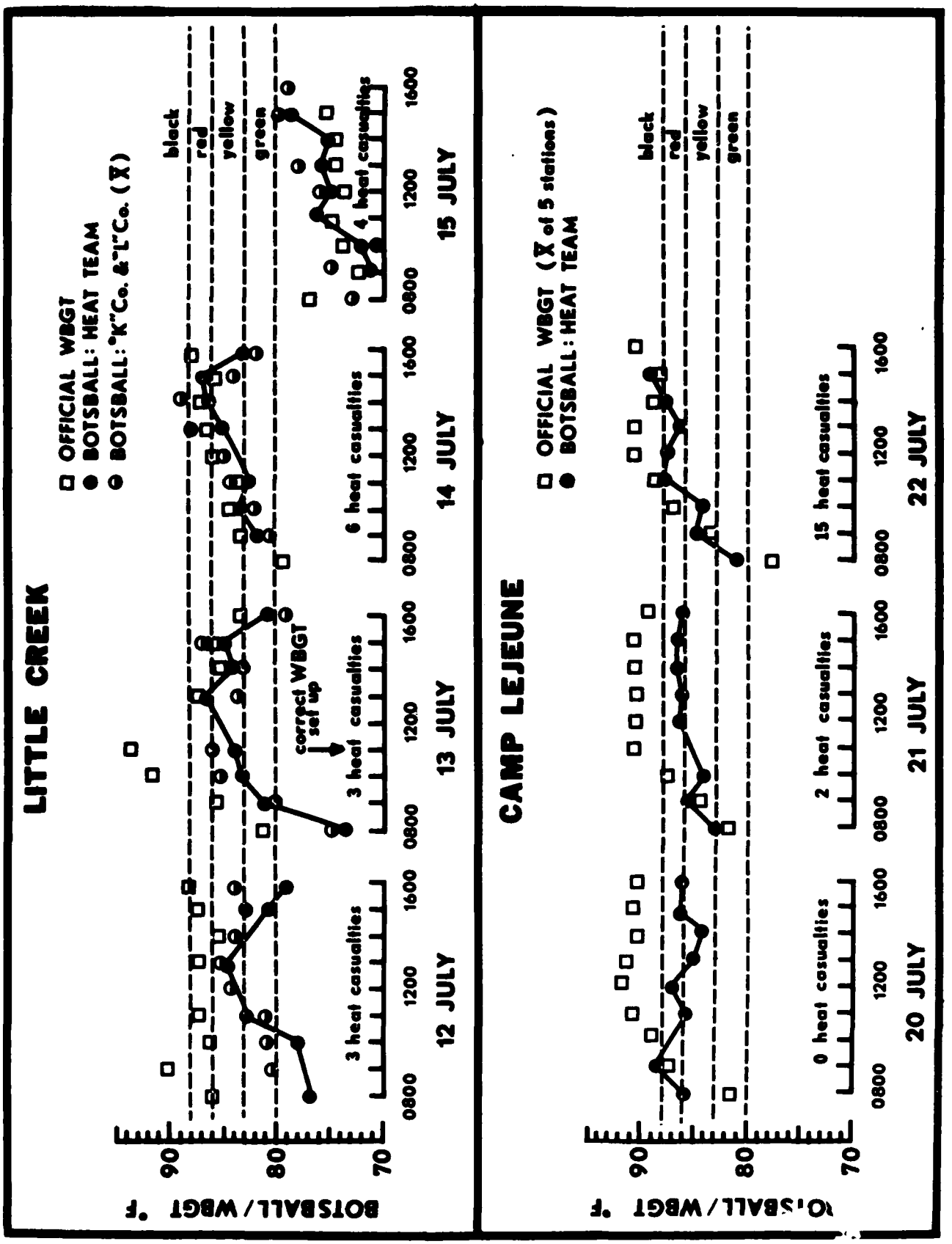

Figure 1. Botsball and WBGT Readings and the Occurrence of Heat Casualties.

cases. Since this was the last full day of training at Little Creek there may have been additional pressure to complete the training as quickly as possible. In addition, three of the four casualties came from "K" company which had carried out its night raid exercise on the previous night. This suggests a fatigue component commonly referred to as "lack of sleep".

3. The amphibious landing at Camp Lejeune took place on 21 July. Despite the relatively high Botsball readings on that day, only two heat casualties were reported. The use of the amphibious tracked vehicles in the landing exercise may have accounted for this apparently low incidence in two ways: first, due to conditions inside the amtracks during the landing phase, there is the strong possibility that the diagnosis of heat injury may have been missed in some cases: the relatively high frequency of other dramatic symptoms (nausea, vomiting, dizziness) attributable to the inhalation of engine fumes and/or sea sickness would tend to overshadow any direct diagnosis of heat injury. Second, the level of physical exertion required on this landing did not appear to approach that required on the BBO course at Little Creek: the landing at Lejeune was "unopposed" and was executed in armored vehicles. Unfortunately, it must be emphasised that since we have no data on heat levels inside the vehicles during the assault phase, no firm conclusions can be drawn with regard to the observed low rate of heat injury on that day.

4. The day following the landing at Camp Lejeune, 22 July, was by far the worst day in terms of the number of heat casualties: fifteen individuals were stricken on that day. Several factors probably contributed to this: first, this was the hottest day of the entire exercise. Botsball readings had moved into the black range by 1400 hours. Second, this was the time in the exercise when the troops were pushing inland from the beach against the defending forces, and fairly high levels of physical exertion were required. Third, this was the last full

day of the exercise and it seems likely there would be extra pressure to gain objectives and complete the exercise on time perhaps at the expense of proper hydration.

For some reason, no Botsball readings were recorded by the test companies' corpsmen during the assault phase at Camp Lejeune. This resulted in an unfortunate loss for the overall experimental effort. Not only is there a substantial gap in the local environmental data for these units for 22 July (when approximately 50% of all the heat casualties occurred) but, more significantly, valuable confirmation of the practical feasability of the heat doctrine/Botsball concept under intensive, sustained, simulated combat conditions has not been achieved. There is no doubt that the corpsmen responsible for the measurements were well trained and highly motivated: These individuals had done an outstanding job at Little Creek. It seems likely that the immediacy of their other medical responsibilities simply took precedence over Botsball data collection. This experience may be valuable, however, in the sense that it points to fundamental realities of the combat environment: 1) The importance of the Botsball reading and the heat doctrine must be emphasized repeatedly in training or it will be forgotten in the combat situation, 2) The company corpsmen, regardless of training or motivation, may face almost continuous priority situations which preclude making the Botsball measurements. An alternative candidate for this responsibility might be the radioman: He is already operationally close to the input process for command decision making and would have direct access to the communication net.

There were complicating factors which contributed to less than desirable experimental conditions and which were beyond experimental control. The test Companies had no opportunity to fully implement the provisional water doctrine and work/rest cycles based upon their individual Botsball readings during the

training periods. Their activity was determined by the experienced course instructors who modified or curtailed training as WBGT readings were reported and activity modification was required. Test Company Commanders were not given the authority to exceed the established base heat stress guidelines as reported by the WBGT Index.

Assistant instructors, usually reservists on temporary duty, were less sensitive to the WBGT readings and the corresponding heat conditions. They would allow individuals to push themselves beyond the activity level established by the WBGT guidelines. Redfaced, overweight, physically out-of-shape marines were pushed during the obstacle course. However, both the higher WBGT readings and the presence of the Heat Team appeared to increase the number of "walk through" exercises.

During the assault phase, where the possibility for utilizing the provisional water doctrine and work/rest cycles existed, test Company Commanders were quite frank in their commitment to accomplish their mission and consequently assigned the Heat Experiment a much lower priority. However, they did assume the responsibility for insuring that their men were drinking the amounts of water the provisional water doctrine required, based upon the environmental conditions.

The presence of contaminated MCI's and the difficulty of "passing the word" indicating which lot was good for consumption and which one wasn't caused many individuals to refuse all MCI's for the duration of the exercise. With no food intake and no provision for supplimental salt as a result, the possibility for salt depletion existed.

Other observations that contributed to the effectiveness of individuals operating in hostile heat environments are less demonstrable but are no less important operationally. Individuals confined for extended periods in Amtracks

begin to suffer the effects of heat prior to disembarking. Two canteens of water is not sufficient if a landing is prolonged. Reportedly, temperatures within the Amtrack frequently reach 130-140. This is Heat Condition "4" and requires 2 qts of water per hour. The lack of available water on the beach discourages individuals from consuming the water they do have. The natural tendency is to drink freely only when water replenishment is assured. Additional problems occur as gasmasks are required due to the presence of exhaust fumes. Individuals nauseated in the early stages of dehydration are not ready to fight when they hit the beach.

Interviews with senior non-comissioned officers reveal the prevailing attitude that water is not really critical. There is still a remnant of belief that if a marine is really tough, he can get used to going without a drink. However, the results of the increased emphasis on overdrinking has not been lost. The data is being acknowledged, but it has not been incorporated into behavior patterns. This was evident as a training company walked past a water buffalo with empty canteens, expecting to obtain water later at a more convenient time, only to find that the expected water buffalo had been moved. The realization that water is absolutely necessary for optimum performance will be accomplished when individuals obtain water at every opportunity.

Conclusions

1. The provisional heat doctrine was found to reduce the incidence of heat illness in the test companies by 50%. Based on these results and the CAX 8-80 results it appears that the Provisional Heat Doctrine should be adopted for general implementations.

2. The pattern of incidence of heat illness during these exercise strongly suggests exertion/fatigue and dehydration components which substantially

increase the risk of heat illness even under very moderate (Botsball 80°F or less) environmental heat conditions.

3. There is evidence that, in implementing the provisional heat doctrine, the corpsmen may not be able to handle both the taking and recording of the Botsball measurment and their medical responsibility in a combat situation. It would, therefore, be desirable to assign this responsibility to some other member of the unit, such as the radio man.

4. There exists a serious and potentially dangerous inconsistency in the codes being used to classify the level of heat stress as determine by the WBGT measurement: training facilities at Little Creek defined heat condition I as WBGT = 88°F, (most severe heat condition) but the correct code, listed in the operation plan for this exercise, defined heat condition I as WBGT = 80°F, (least severe heat condition). An information control process must be initiated to effectively delete inconsistent or out of date codes from the WBGT system.

5. The central weather stations at both Little Creek and Camp Lejeune were producing inaccurate WBGT data. Of the six weather stations inspected by us, all were found to have technically incorrect or inadequately maintained WBGT set-ups. This resulted in meausurement errors which ranged up to 13°F above true. Individuals under these WBGT index systems, who have observed strenuous activity under inaccurately reported heat conditions will continue to make decisions concerning troop activity with a false sense of security when accurate heat conditions are reported. A program of regular inspection of the WBGT stations should be instituted to ensure conformance with standards.

6. There is a persistent and pervasive belief that, if a marine is really tough, he can get used to going without water. This is a misinformed and potentially lethal attitude. A substantial need still exists to educate personnel, senior noncommissioned officers in particular, on the subject of adequate water discipline.

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